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An interest in plants is a natural one. Plants are everywhere about us, and are useful in many and exceedingly important ways. The botanical teaching of the last ten or fifteen years has been missing its opportunity to serve and take advantage of this interest, by busying itself too exclusively with plants which most people never see except in the class room, and in which they have no practical interest.

The old course of study made better use in many respects of one term than the newer course has done of a year. It left much to be desired and the newer course made up its shortcomings; but it did this at too great an expense when it threw away the familiarity with the different kinds of common flowering plants, and the excursions, and the love of the woods which the students gained in old-time classes. There are hopeful signs of a backward swing of the pendulum. And it is well that this come before field botany is quite forgotten.

E. B. COPELAND

INDOOR HUMIDITY

TO THE EDITOR OF SCIENCE: Notwithstanding the conclusions reached in Dr. Ingersoll's interesting letter on this topic, something may perhaps be said in favor of a humidity considerably higher than 40 per cent., and nearer the 66 or 70 per cent. favored by "most authorities."

The writer has made experiments similar to those of Dr. Ingersoll, but with the following differences: gallons evaporated per day, 18 to 20, instead of 25 or more; volume of house actually served by the hot and humid air supply, 17,000 instead of 20,000 cubic feet; humidity maintained with comfort, over 60 per cent., instead of 40 per cent. Another important factor, and there are yet more, is that of house temperature. Unfortunately, Dr. Ingersoll has omitted any mention of this; but, judging from common American practise, one may, perhaps, assume a day temperature of 70°. Now in a Scots household, such as the writer's, a temperature nearer 60° is

thought more comfortable, and was that aimed at in our experiments. And herein enters the most interesting feature of the case, that the weight of water present per cubic foot, and hence the possible amount of dew deposit, is approximately the same with 40 per cent. saturation at 70° as with 60 per cent. saturation at 60°! Thus, after all, those at least of the authorities that are European may not be so far wrong in their estimate, and, truly, one does like to say a little, if only occasionally, in favor of the authorities.

The writer would agree most heartily with Dr. Ingersoll in the statement that any serious effort to raise the indoor humidity is very well worth while.

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SCIENTIFIC BOOKS

The Purchasing Power of Money; Its Determination and Relation to Credit, Interest and Crises. By IRVING FISHER, assisted by HARRY G. BROWN. New York, The Macmillan Company. 1911. Pp. xxii + 505.

Although Irving Fisher is a good propagandist and can use arguments which appeal to the man in the street, his reasoning is based upon critical, logical, scientific analysis. One of the propositions which he has recently been actively promoting is international monetary reform looking toward the elimination or restriction of those disastrously wide variations in prices which may be due to the irregularities of the world's gold production. The principles upon which his suggestions for regulating the general price level are based are expounded in his "Purchasing Power of Money." An early proficiency in mathematics and interest in the mathematical theory of prices has led him naturally to a quantitative or quantity theory of money which he builds up with a deep knowledge and appreciation of scientific method. This attitude is a justification for SCIENCE to show an interest in his work which it could hardly exhibit in the case of ordinary studies in economics.

Fisher starts from the obvious identity that what is spent per annum is equal to what is spent. If E be expenditure in cash and E' expenditure by check, we have

$$E + E' = (E + E').$$

Now if M be the amount of money in circulation, the average velocity V of circulation or rate of turnover of this money per annum may be defined by the equation

$$E = MV;$$

and if M' be the amount of deposits subject to check, the average velocity V' of turnover of deposits may be defined by

$$E' = M'V'.$$

Further, if Q_i be the quantity of a substance i which is bought and p_i the price, $p_i Q_i$ will be the amount spent in this transaction. Total expenditure $(E + E')$ during the year will be the sum $\sum p_i Q_i$ of the various products $p_i Q_i$ for the transactions of the year; or

$$(E + E') = \sum p_i Q_i.$$

This equation may be modified by the introduction of the total trade T for the year and the average price P . Then

$$\sum p_i Q_i = PT,$$

and the fundamental identity becomes

$$MV + M'V' = PT, \quad (1)$$

which is *the equation of exchange*¹ (Chaps. I.-III.).

Such a mathematical identity is, as every one knows, a mere truism whose validity nobody should be rash enough to dispute. It might therefore be thought, and it is apparently the idea of many, that, being a truism, the equation is worthless, that nothing more can be obtained from it than has been put into it. This opinion has been somewhat of a

stumbling block relative to all mathematics, and even such a prince of mathematicians as Poincaré did not think it beneath him, in his philosophizing moments, to try to explain why mathematics can really amount to something, why it does give results which are valuable, why it is really creative. We need not enter upon that question here; we may admit that by proper discussion and transformation mathematical identities do reveal important relations not obvious in the original form of the identity. Let us admit the same in regard to the identity (1).

We now have under our eyes six separate elements, M , M' , V , V' , P , T , entering into the equation of exchange, and we may focus our attention upon the effects produced upon certain of these elements by supposed variations in the others. For instance, if the amount of trade T and the velocities V , V' of circulation of money and deposits remain constant from year to year while the amounts of money M and of deposits M' increase, it follows indubitably that the general price level P must rise. On the other hand, if M , M' , V , V' remain constant while trade increases, the level of prices must be lowered. As a matter of fact the statistics for the United States for 1896 and 1912 are as follows:

	M	M'	V	V'	T	P
1896 ...	0.88	2.71	18.8	36.6	191	60.3
1912 ...	1.70	8.15	21.0	53.0	435	107.6

If we regard the price level P as the passive element, the effect, and the other elements as causes,² we shall attribute the rise in the price level chiefly to the great increases in deposits subject to check and in their velocity; for the product MV has about kept pace with the increase in trade, whereas $M'V'$ has greatly outstripped it.

When it is a question of such actual figures as these, we have reached a stage somewhat remote from the equation (1) in the sense in which it was originally set up. Originally MV stood merely for the expenditures

¹This simple form of the equation applies only to self-contained communities where each transaction is settled during the year. The author, however, discusses (p. 370 ff.) the modifications necessary when unsettled accounts and intercommunal trade are present, and comes to the conclusion that the changes are insignificant in the case of the United States.

²The author gives reasons to justify this assumption.

E of cash, which would naturally be impossible to calculate directly; now MV stands for an estimate of these expenditures obtained by a searching analysis of available financial data; that is, the evaluation of E is indirect. The same is true of $M'V'$ and E' . And the elements P and T are likewise found by diligent compilation and discussion of commercial data instead of by direct quest among the buyers and sellers. Such a change of aspect is found constantly in the correlation of theoretical and experimental physics. An equation is set up by a series of definitions or demonstrations. No amount of data can prove the equation; its validity is *a priori*. But the need of an experimental verification of the equation is none the less great; for in the applications to practical problems it is precisely such experimental data which must be used in the equation; and unless proper means of evaluating the terms of the equation are found, the importance of the theory is nil.

The author examines in lucid detail the various interrelations of the six elements which enter the equation of exchange. He comes to the conclusion that normally the element P may be regarded as passive, as the effect of the other elements, and that normally the ratio M'/M of deposits to circulation tends to constancy. He then goes on to an exhaustive discussion of what happens in transition periods where prices are rapidly rising (or falling) and where a certain amount of abnormality enters (Chap. IV.). The use of the word normally in the statement that normally the ratio M'/M tends to constancy seems rather unfortunate. The ratio M'/M has increased more or less steadily³ for the United States from 3.1 in 1896 to 4.8 in 1912, and according to the author's estimate⁴ for the whole gold-standard world the ratio will increase from 1.25 in 1911 to 2.25 in 1926. Thus the whole period of thirty years must be

regarded as abnormal. With this use of the word it might well be that most periods are abnormal. We would not dispute that in the cycles between successive crises there should be certain periodic variations of the ratio, and that sudden changes in the world's gold production should bring about other erratic variations, and it is these two things that the author seems chiefly to have in mind; but it seems evident that a certain secular increase in M'/M should be expected to accompany normal advances in banking facilities and the attendant increase in use of these facilities by the public.⁵

The refined quantity theory of money is contained in the equation (1) where all the elements except P are considered as independent variables; it is a much cruder theory which is based upon the assumed constancy of M'/M . No careful reader of Fisher's work will fall into any crude errors or attribute such errors to the author; but there are enough careless readers, who may seize upon the phrase "quantity theory of money" and be led into useless discussion forgetful of the developments of Chaps. VIII. and XII., that we could wish the author had made less of the "normal" dependence of M' on M . Those who will but observe that in the equation of exchange for 1896 the term $M'V'$ was about six times as great as MV , and in 1912 about twelve times as great, will see the great danger and instability introduced into the system by making the preponderating term depend upon the small one.

The ascription of the rapid rise of prices during the past fifteen years to the great flood of gold has become increasingly popular of late, particularly since the impressive symposium on the subject in the first volume of *Moody's Magazine*. A facile argument may be constructed, namely, that the more gold we have relative to other possessions the less valuable is any given amount of it to us and the

³In the table on p. 304 the value 7.77 for M' for 1904 seems to upset the steadiness; but this number should obviously be 5.77.

⁴*American Economic Review*, September, 1912.

⁵A leading trust company says that now ten women have a check account where only a few years ago only two had one, and uses this fact to attract further accounts.

more readily will we exchange it for other goods; hence prices of other goods, as measured in gold, must rise. Such an argument does not introduce the equation of exchange; it is based on a sort of value theory of gold, partly quantitative, but largely psychological. We must not forget that according to theoretical economics the equilibrium of exchanges and the relative prices of goods do depend on the marginal utilities of the goods, that is, upon the relative values of the final infinitesimal quantities of goods entering into the exchange as these values are estimated by the individual traders. The value theory or, better, the marginal utility theory is therefore fundamental and the above mentioned facile argument is qualitatively correct.

When, however, we desire to take the equation of exchange as fundamental and for a quantitative discussion this seems the readiest if not the only thing to do, we have to examine merely the effects of a flood of gold upon the various elements of that equation. Suppose that 258 grains of standard gold are mined and turned over to the government for coinage into \$10 or for exchange for a gold certificate of like amount. Then M is thereby increased to the extent of \$10. As V is about 20, there is a contribution of some \$200 to the product PT . If a half billion of gold were thus injected into the circulation in the United States each year, it would cause an increase of ten billion in PT . Now in recent years trade has been increasing here in the United States at the rate of some fifteen billions per year. The half billion of gold, practically the total world output per year, would therefore not suffice to maintain prices, to say nothing of advancing them, here in our own country if we added all of it to the circulation, and provided, of course, that we did not otherwise inflate the circulation.

Suppose, however, that the 258 grains of gold went into the reserves of a bank operating under a rule of 25 per cent. reserve against deposits. The quantity M' would then be swelled not merely by \$10, but by \$40, and as V' is in the neighborhood of 50, the term

$M'V'$ would be increased by something like \$2,000, ten times as much as the term MV was increased on the previous hypothesis. Hence an addition of 75 millions in gold to the reserve stocks of banks operating under a 25 per cent. ratio would swell the term $M'V'$ by the fifteen billion requisite to keep pace with trade, and a greater increase of gold would more than keep the pace, it would force prices to rise. These figures are very rough and are cited merely to enforce the idea that it is the expansion of credit by the influx of gold into bank reserves, and not the increase of gold in circulation, which must be the chief cause in the rise of prices as determined by the equation of exchange. We make no attempt to take secondary effects into consideration.

In the last chapter of the work the author discusses the possibility of stabilizing the purchasing power of the dollar, that is, of maintaining an approximately constant price level. The scheme he there suggests for accomplishing this purpose has undergone successive modifications in a considerable series of printed papers or privately circulated monographs until its present form appears in an article only two months old.⁶ Unfortunately he abandons his equation of exchange and proceeds with general arguments or special hypotheses which seem far from substantial foundation. Such a change in style may be necessary to make an impression on a general public, and it is only by making such a general impression that any actual change of standard of value could be made into law; but for a mathematician the way would have been better lighted had the equation of exchange been constantly in evidence.

Briefly, the plan is to have the various gold-standard governments of the world pay less for gold as the general level of prices rises. Thus instead of giving a dollar for 25.8 grains of coin-gold, the United States would require 27 or 30 grains in exchange for a dollar. The author has an elaborately worked

⁶ "A Compensated Dollar," *Quarterly Journal of Economics*, Vol. 27, February, 1913.

out plan for changing the price of gold and for preventing the government from being at the mercy of gold speculators. He gives detailed tables and charts to show what, on certain assumptions, would have been the results if his system had been in operation for certain periods of years. His suggestions have called forth a very large number of commendatory comments from a great variety of persons eminently able to judge of their value from many diverse points of view. There seems to have been but small adverse criticism from any quarter. As for ourselves, untrained in such matters and deprived of the direct guidance of the equation of exchange, we will acknowledge that a bewildering vacillation is in possession of us, swinging us now to complete confidence in the plan, and again to absolute distrust of it.

At the present moment we are extremely pessimistic about the efficacy of Dr. Fisher's remedy. Statistics show very well that the term in the equation of exchange which causes the trouble is $M'V'$. To keep prices constant we have to keep the increase of $M'V'$ sensibly equal to the increase of trade. Now if a gold miner has to take fewer dollars from the government for a given amount of gold, there is a slight diminishing of the increase of M , and if he deposits the gold certificate subject to check, there is a slight reduction of the increase of M' . But these small alterations of the increases of M or M' would make only an insignificant effect upon the equation of exchange. Of course, if the price of gold were lowered enough to shut down some of the gold mines, the effect would be of considerable magnitude, and thus ultimately the regulation might be accomplished. But this would be at a very much altered price of gold; for gold mining is a pretty profitable business. Moreover, it would probably be an extremely unstable stabilization of the dollar; we have only to look at the market for copper metal over a long series of years to see how violent are the swings of prices when regulation of demand and supply takes place through the closing down or opening up of the less efficient mines.

When the government requires more gold for a dollar all the gold certificates outstanding, though presumably redeemable in the new ratio for gold, are actually backed by less than the requisite amount. Within moderate limits there would be, as the author says, no danger in this arrangement. Indeed, there has been at times a great cry against the wastefulness of gold practised by the United States in keeping a great hoard at par with the gold certificates,¹ whereas if the gold were available for banking purposes, it would serve as the basis of an enormous credit. But this is precisely what we do not want if we are intent on keeping prices down. It would add much to the possible efficacy of Fisher's regulatory plan if the government were required to maintain all the gold certificates at par with the new weight of gold. The author, however, specifically states that this need not be required. The matter is not so important as it might be, owing to the smallness of the term MV in the equation of exchange.

What about the banks? If the government is not to keep its certificates at par with the new figure for gold, are the banks to be compelled to compute their percentage gold reserve on the new basis? If so, the scheme is not very sure of enthusiastic support from bankers. For instance, if a banker has deposits of one million dollars on which he must keep a reserve of 20 per cent. in gold, he has a reserve of \$200,000, or 5,160,000 grains in gold, at the present exchange ratio of 25.8 grains to the dollar. If the ratio is altered to 25.9 grains to the dollar and he is still required to keep a 20 per cent. reserve, he must add 200,000 grains, or \$775, at the old evaluation, to his reserve. This, so far as he is immediately concerned, is equivalent to leaving the exchange ratio for gold unchanged and raising his gold-reserve requirement to 20.0775 per cent. This would undoubtedly have the

¹ We believe we are right in saying that R. Goodbody once suggested that some of the evils of our inelastic currency system could be alleviated, if not remedied, by calling in the certificates and paying out the gold.

effect of absorbing to a certain extent the present oversupply of gold. It would scarcely be effective in keeping down the average price level until a far greater rise in the effective reserve requirement had been made.

The calculations by which the author shows that had his system been in vogue during the last few years the price level would have remained sensibly constant are based upon the assumption that a one per cent. rise in the amount of gold demanded for a dollar brings about a one per cent. fall in the price level. On a certain vague value theory of money this may appear reasonable, but from the point of view of the equation of exchange it is far from obvious. The one thing we must bear in mind is that $M'V'$ must be kept under control, and to a less extent MV . The author would have done much better to stick to his equation and calculate what effect his proposition would have had upon the changes in $M'V'$. That would have been more scientific.

Lowering the price of gold could diminish the increase of M' in three ways. First, by slackening the output. The lowering would probably have to go a long way, however, before the slackening became considerable. Second, by diverting gold from banking uses into the arts. Whether the arts, which now consume only about one third the annual output as against two thirds which goes to monetary and banking uses, could well absorb a much greater quantity of gold unless the price were very much lowered is not evident. Third, by augmenting the effective reserve requirements, as above explained. What we must have is some sort of a sink for gold. Indeed, it occurs to us to suggest that without at all disturbing the ratio of exchange between gold and dollars, we could accomplish the desired regulation of prices by insisting upon the strengthening of reserves. Suppose all banks receiving deposits subject to check were compelled to maintain a 50 per cent. reserve on all new business beginning with 1914. An increase of 15 billions in trade would then call for 150 millions in gold instead of the much smaller

amount at present required. To make banking less profitable and safer might be easier and more directly effective than to discourage gold mining.

So much attention has been devoted to Fisher's plan for regulating the price level because the subject is actively under discussion all over the world, because Fisher has failed to maintain the scientific excellence with which he started out, and because he has apparently developed a method of attack which is better and surer than the one he uses. In view, however, of the almost unanimous indorsement he has received we feel very apologetic about these criticisms we offer.

Some parts of the work we have scarcely touched upon, parts which from a scientific point of view might seem to merit more notice in this weekly than the parts we have discussed. For instance, there is in Chap. X. an analysis of the best index numbers of purchasing power and in an appendix a masterly analytical treatment of the various types of index numbers which show the defects and the advantages of different types for different purposes. And in general there is much of excellent scientific value throughout the appendices. But we must pass it by, as we do much of the historical matter (Chap. VII.), and the discussion of indirect influences which exert secondary effects on the equation of exchange (Chaps. V.-VI.).

The arrangement of the book is very thoughtful toward the reader. Not only are the table of contents and the index exceptionally full, but there is a little foreword wherein readers of different types are instructed as to where they will find what they in particular are looking for. The mathematical work is relegated to the appendices, and so are the more subtle developments. The book should be read by everybody at all interested in any of the questions it treats.

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The Mesozoic Flora of Graham Land. By T. G. HALLE. Wissenschaftliche Ergebnisse d. Schwedischen Süd-polar-Expedition, 1901-